

# Water intoxication

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In medicine, **water intoxication** (also known as **hyperhydration** or **water poisoning**) is a potentially fatal disturbance in brain function that results when the normal balance of electrolytes in the body is pushed outside of safe limits by a very rapid intake of water.

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## Physiology of water intoxication

Body fluids contain electrolytes (particularly sodium compounds, such as sodium chloride) in concentrations that must be held within very narrow limits. Water enters the body orally or intravenously, and leaves the body primarily in the urine and in sweat. If water enters the body more quickly than it can be removed, body fluids are diluted and a potentially dangerous shift in electrolyte balance occurs.

Most water intoxication is caused by hyponatremia, an overdilution of sodium in the blood plasma, which in turn causes an osmotic shift of water from extracellular fluid (outside of cells) to intracellular fluid (within cells). The cells swell as a result of changes in osmotic pressure and may cease to function. When this occurs in the cells of the central nervous system and brain, water intoxication is the result. Additionally, many other cells in the body may undergo cytolysis, wherein cell membranes that are unable to stand abnormal osmotic pressures rupture, killing the cells. Initial symptoms typically include light-headedness, sometimes accompanied by nausea, vomiting, headache and/or malaise. Plasma sodium levels below 100 mmol/L (2.3g/L) frequently result in cerebral edema, seizures, coma, and death within a few hours of drinking the excess water. As with an alcohol poisoning, the progression from mild to severe symptoms may occur rapidly as the water continues to enter the body from the stomach or intravenously.

A person with two healthy kidneys can excrete about 1.5 litres of water per hour at maximum filtration (other studies find the limit to be as little as 0.9L/h [1] ([http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=11732457&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11732457&dopt=Abstract))). Consuming as little as 1.8 litres of water in a single sitting may prove fatal for a person adhering to a low-sodium diet, or 3 litres for a person on a normal diet. However, this must be modulated by potential water losses via other routes. For example, a person who is perspiring heavily may lose 1 L/h of water through perspiration alone, thereby raising the threshold for water intoxication. The problem is further complicated by the amount of electrolytes lost in urine or sweat, which is variable within a range controlled by the body's regulatory mechanisms. Water intoxication can be prevented by consuming water that is isotonic with water losses, but the exact concentration of electrolytes required is difficult to determine and evolves over time, and the greater the time period involved, the smaller the disparity that may suffice to produce electrolyte imbalance and water intoxication.

# Persons at high risk of water intoxication

Certain activities and conditions put a person at elevated risk of water intoxication.

## Runners

Marathon runners are susceptible to water intoxication if they drink only water while running. Although sweat is relatively hypotonic compared with body fluids, marathon runners perspire heavily for long periods, potentially causing their sodium levels to drop when they consume large amounts of fluids to quench their thirst. The replacement fluids may not contain sufficient sodium to replace what has been lost, and this puts them at high risk for water intoxication. Medical personnel at marathon events are trained to immediately suspect water intoxication when runners collapse or show signs of confusion. Properly designed electrolyte-replacement drinks and some sports drinks include electrolytes that make them roughly isotonic with sweat, which helps to prevent water intoxication.

Note that overconsumption of sodium (in drinks or food), as well as inadequate intake of water, can cause hyponatremia, a disorder that is nearly the opposite of water intoxication and equally dangerous. Improper use of salt tablets can cause hyponatremia.

## Overexertion and heat stress

Any activity or situation that promotes heavy sweating can lead to water intoxication when water is consumed to replace lost fluids. Persons working in extreme heat and/or humidity for long periods must take care to drink and eat in ways that help to maintain electrolyte balance. Persons using drugs such as MDMA may overexert themselves, perspire heavily, and then drink large amounts of water to rehydrate, leading to electrolyte imbalance and water intoxication. Even persons who are resting quietly in extreme heat or humidity may run the risk of water intoxication if they drink large amounts of water over short periods for rehydration.

## Psychiatric conditions

Psychogenic polydipsia is the psychiatric condition in which patients feel compelled to drink large quantities of water. The condition is often a single symptom in a broader syndrome of psychiatric indications. Patients suffering from psychogenic polydipsia are at high risk of water intoxication, gaining up to 15 pounds in an hour, especially as the initial symptoms of lightheadedness and confusion may be misdiagnosed by care-takers as due to other causes.

## Unusual water losses in disease

Diarrhea and vomiting can result in very large electrolyte losses, and although drinking water will replace lost water, the lost electrolytes may not be adequately replaced, which can result in water intoxication. Replacement fluids for vomiting and diarrhea should be properly balanced to make them isotonic with the fluids lost in these conditions. Special formulations exist for oral rehydration therapy in these cases.

A great many disorders can affect electrolyte balance, especially disorders of the kidneys. Diuretic therapy, mineralocorticoid deficiency, osmotic diuresis (as in the hyperglycemia of uncontrolled diabetes), and the multiple disorders associated with AIDS are other common causes of electrolyte imbalance, although they do not always produce water intoxication.

## Iatrogenic water intoxication

When an unconscious person is being fed intravenously (e.g., total parenteral nutrition) or via a nasogastric tube, the fluids given must be carefully balanced in composition to match fluids and electrolytes lost. If the fluids administered are hypotonic with respect

to fluids lost, electrolyte imbalance and water intoxication may result. The latter may not be immediately obvious in an unconscious patient. The electrolyte status of patients on TPN must be monitored carefully even when they are ambulatory.

## Famous cases of water intoxication

In a much-publicized case of fraternity hazing, four members of the Chi Tau House at California State University, Chico pled guilty to forcing 21-year-old student Matthew Carrington to drink excessive amounts of water while performing calisthenics in a frigid basement as part of initiation rites on 2 February 2005[2] (<http://www.newsreview.com/chico/Content?oid=oid%3A33779>). He collapsed and died of heart failure due to water intoxication.

Other fatalities due to water intoxication include Leah Betts [3] (<http://thedeia.org/hyponatremia.html>), Anna Wood [4] ([http://www.erowid.org/chemicals/mdma/mdma\\_health5.shtml](http://www.erowid.org/chemicals/mdma/mdma_health5.shtml)), 2002 Boston Marathon competitor Cynthia Lucero [5] (<http://www.thebostonchannel.com/newscenter5/1610699/detail.html>), and Washington, D.C. police officer James McBride [6] (<http://www.washingtonpost.com/wp-dyn/content/article/2005/08/10/AR2005081001460.html>). New Zealand race-walker Craig Barrett collapsed during the last kilometer of the 50 km walk in the 1998 Commonwealth Games in a non-fatal case of water intoxication.

## Prevention of water intoxication

Water intoxication can be prevented if a person's intake of water and electrolytes closely matches his or her losses. The body's regulatory mechanisms provide a very generous margin of safety if the two are imbalanced, but some extreme activities (such as heavy, prolonged physical exertion), as well as disease states, can overwhelm or impair these mechanisms. Avoiding situations that provoke extreme or prolonged perspiration and/or drinking fluids that are specially balanced to replace lost electrolytes can help to prevent intoxication. Eating regularly can provide needed electrolytes if only normal water is available for rehydration.

Sports drinks are popular among athletes because they provide the necessary electrolytes to support extended exercise. They help keep the body balanced and carrying the right amount of fluids. However, not all drinks advertised as sports drinks are suitable for this purpose, and professional advice should be sought for potentially risky situations such as those described above.

Note that a person's innate sense of thirst is triggered by overall dehydration, not by changes in electrolytes. Thus, it is possible to develop water intoxication while trying to satisfy thirst, if one drinks a great deal of water over a short period. A dangerous drop in electrolytes, such as the hyponatremia that leads to water intoxication, will not have any effect on thirst.

For people suffering from dehydration due to the heavy perspiration associated with heavy exertion or heat stress, drinking water to rehydrate is much more important than avoiding water intoxication, since the former is extremely common and the latter is rare. One should never avoid drinking water under such conditions; instead, other steps should be taken to ensure that electrolytes are replaced as well, as noted above.

## See also

- electrolytes
- hyponatremia
- hypernatremia
- oral rehydration therapy
- polydipsia

## References

- The Merck Manual (<http://www.merck.com/mrkshared/mmanual/section2/chapter12/12b.jsp>)

- [7] (<http://chemistry.about.com/cs/5/f/blwaterintox.htm>) "Water Intoxication" at About.com Chemistry

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Category: Electrolyte disturbance

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# HalfLyte<sup>®</sup>

and Bisacodyl Tablets  
**Bowel Prep Kit**  
PEG-3350, sodium chloride, sodium  
bicarbonate and potassium chloride for oral  
solution and bisacodyl delayed-release tablets

## DESCRIPTION

Each HalfLyte<sup>®</sup> and Bisacodyl Tablets Bowel Prep Kit (Polyethylene glycol 3350, sodium chloride, sodium bicarbonate and potassium chloride for oral solution and bisacodyl delayed release tablets) consists of:

**One pack of 4 bisacodyl delayed release tablets:** Each pink, round, enteric coated delayed release tablet (stamped "BRA") contains 5 mg bisacodyl, USP ( $C_{22}H_{19}NO_4$ ); MW=361.40. **Inactive ingredients:** lactose (anhydrous) NF, microcrystalline cellulose NF, croscarmellose sodium NF, magnesium stearate NF, eudragit L 30-55, polyethylene glycol 400, talc USP, gelatin, calcium sulfate (anhydrous) NF, confections sugar, kaolin USP, sucrose NF, opalux pink, beeswax, carmuba wax.

The bisacodyl delayed release tablets are administered orally prior to drinking the solution.

**One 2 liter bottle of HalfLyte<sup>®</sup> (PEG-3350, sodium chloride, sodium bicarbonate and potassium chloride for oral solution):** A white powder for reconstitution containing 210 g polyethylene glycol 3350, 2.86 g sodium bicarbonate, 5.6 g sodium chloride, 0.74 g potassium chloride and 1.0 g flavoring ingredient (if applicable). When dissolved in water to a volume of 2 liters, the solution is isotonic. The solution is administered orally as a gastrointestinal lavage in combination with four bisacodyl delayed release tablets. All solutions are clear and colorless.

## CLINICAL PHARMACOLOGY

HalfLyte and Bisacodyl Tablets Bowel Prep Kit induces a diarrhea which cleanses the bowel. Bisacodyl is a contact stimulant laxative. After being hydrolyzed by intestinal brush border enzymes and colonic bacteria, its active metabolite, bis-(p-hydroxyphenyl)-pyridyl-2 methane (BHPM) acts directly on the colonic mucosa to produce peristalsis throughout the large intestine.

The osmotic activity of polyethylene glycol 3350 and electrolytes result in virtually no net absorption or excretion of ions or water.

## INDICATIONS AND USAGE

HalfLyte and Bisacodyl Tablets Bowel Prep Kit is indicated for bowel cleansing prior to colonoscopy.

## CONTRAINDICATIONS

HalfLyte and Bisacodyl Tablets Bowel Prep Kit is contraindicated in patients known to be hypersensitive to any of the components.

HalfLyte and Bisacodyl Tablets Bowel Prep Kit is contraindicated in patients with ileus, gastrointestinal obstruction, gastric retention, bowel perforation, toxic colitis or toxic megacolon.

## WARNINGS

No additional ingredients, e.g. flavorings, should be added to the solution. HalfLyte and Bisacodyl Tablets Bowel Prep Kit should be used with caution in patients with severe ulcerative colitis. Do **NOT** chew or crush the bisacodyl delayed release tablets.

## PRECAUTIONS

**General:** Patients with impaired gag reflex and patients prone to regurgitation or aspiration should be observed during the administration of the solution. If a patient experiences severe bloating, distention or abdominal pain, administration of the solution should be slowed or temporarily discontinued until the symptoms abate. If gastrointestinal obstruction or perforation is suspected, appropriate studies should be performed to rule out these conditions before administration of HalfLyte and Bisacodyl Tablets Bowel Prep Kit.

Patients should avoid consumption of large quantities of water during or after preparation or colonoscopy. Patients with impaired water handling (renal insufficiency or patients taking diuretics) that experience severe vomiting or nausea should be closely monitored including measurement of electrolytes.

**Information for patients:** HalfLyte and Bisacodyl Tablets Bowel Prep Kit produces a watery stool which cleanses the bowel before examination. Prepare the solution according to the instructions on the kit. For best results, no solid food or milk (clear liquids only) should be consumed on the day of the preparation. No antacids should be taken within one hour of taking the bisacodyl delayed release tablets.

Adults swallow all four bisacodyl delayed release tablets with water (do **NOT** chew or crush). The first bowel movement should occur in approximately 1-6 hours after taking the bisacodyl delayed release tablets. Wait for a bowel movement (or maximum of 6 hours) then drink the solution, 1 (8 oz) glass every 10 minutes (approximately 8 glasses). **Drink ALL of the solution.** Rapid drinking of each portion is better than drinking small amounts continuously. A watery bowel movement should occur in approximately 1 hour after drinking the solution. You may experience some abdominal bloating and distention before the bowels start to move. If severe discomfort or distention occurs, stop drinking the solution temporarily or drink each portion at longer intervals until these symptoms disappear.

**Drug Interactions:** Oral medication administered within one hour of the start of administration of the solution may be flushed from the gastrointestinal tract and not absorbed. Do not take the bisacodyl delayed release tablets within one hour of taking an antacid.

**Carcinogenesis, Mutagenesis, Impairment of Fertility:** Long-term studies in animals have not been performed to evaluate the carcinogenic potential of HalfLyte and Bisacodyl Tablets Bowel Prep Kit. Studies to evaluate its potential for impairment of fertility or its mutagenic potential have not been performed.

**Pregnancy:** Category C. Animal reproduction studies have not been conducted with HalfLyte and Bisacodyl Tablets Bowel Prep Kit. It is also not known whether HalfLyte and Bisacodyl Tablets Bowel Prep Kit can cause fetal harm when administered to a pregnant woman or can affect reproductive capacity. HalfLyte and Bisacodyl Tablets Bowel Prep Kit should be given to a pregnant or nursing woman only if clearly needed.

**Nursing Mothers:** It is not known whether HalfLyte and Bisacodyl Tablets Bowel Prep Kit is excreted in human milk, caution should be exercised when HalfLyte and Bisacodyl Tablets Bowel Prep Kit is administered to a nursing woman.

**Pediatric Use:** Safety and effectiveness in pediatric patients has not been established.

**Geriatric Use:** There is no evidence for special consideration when administered to elderly patients. Of the total number of subjects in clinical studies (n=186), 28 percent were aged 65 or older, while 9.1 percent were over 75. No overall differences in safety or effectiveness were observed.

## ADVERSE REACTIONS

Nausea, cramping and abdominal fullness are the most common adverse reactions (occurring in up to 50% of patients) to administration of HalfLyte and Bisacodyl Tablets Bowel Prep Kit. Vomiting occurs less frequently (approximately 2.7% of patients versus 6.7% of patients taking large volume PEG solutions). In clinical studies, most of these complaints were significantly reduced when compared to the 4 liter preparation. Table 1 shows patient rating of symptoms associated with the preparation from 2 clinical studies (n=400). These adverse reactions are transient and subside rapidly. Isolated cases of urticaria, rhinorrhea, dermatitis and (rarely) anaphylactic reaction have been reported with PEG based products which may represent allergic reactions.

Table 1: Patient Symptom Rating Bothersome-Severe Complaints		
	HalfLyte and Bisacodyl Tablets Bowel Prep Kit	4 liters of PEG electrolyte solution
Nausea	17.1%	31.8%
Cramping	9.1%	17.4%
Fullness	22.3%	44.1%
Vomiting	5.9%	13.7%
Overall Discomfort	19.1%	37.3%

Published literature contains isolated reports of serious adverse reactions following the administration of (4L) PEG-ELS products in patients over 60 years of age. These adverse events include upper GI bleeding from Mallory-Weiss syndrome esophageal perforation, asystole, sudden dyspnea with pulmonary edema, and "butterfly-like" infiltrate on chest X-ray after vomiting and aspirating PEG.

In addition, during administration of 4L PEG-3350 bowel cleansing preparations the following serious adverse events were seen: two deaths in end-stage renal failure patients who developed diarrhea, vomiting, dysnatremia; tonic-clonic seizures in patients with and without prior history of seizures. These adverse events have not been reported in HalfLyte and Bisacodyl Tablets Bowel Prep Kit clinical trials.

## DOSAGE AND ADMINISTRATION

HalfLyte and Bisacodyl Tablets Bowel Prep Kit is administered orally. Ideally, the patient should only consume clear liquids (no solid food, no milk) prior to HalfLyte and Bisacodyl Tablets Bowel Prep Kit administration. No antacids should be given for at least one hour before beginning the regimen.

**Oral administration:** Swallow all four bisacodyl delayed release tablets with water (do **NOT** chew or crush). The first bowel movement should occur in approximately 1-6 hours after taking the bisacodyl delayed release tablets. Wait for a bowel movement (or maximum of 6 hours) then drink the solution at a rate of 1 (8 oz) glass every 10 minutes (approximately 8 glasses). **Drink ALL of the solution.** Rapid drinking of each portion is preferred to drinking small amounts continuously. A watery bowel movement should occur in approximately 1 hour after drinking the solution.

The recommended regimen is to consume clear liquids only (no solid food, no milk) the day of the preparation, take all four bisacodyl delayed release tablets at noon, following the first bowel movement or a maximum of 6 hours, begin drinking the solution.

**Preparation of the solution:** The solution is prepared by filling the container to the 2 liter mark with water, cap the bottle and shake to dissolve ingredients. Dissolution is facilitated by using lukewarm water. The reconstituted solution may be refrigerated and should be used within 48 hours. All reconstituted solutions are clear and colorless.

## HOW SUPPLIED

HalfLyte and Bisacodyl Tablets Bowel Prep Kit is available in Lemon-Lime flavor. Each foil lined blister pack contains 4 (5 mg each) bisacodyl delayed release tablets for ingestion prior to drinking of the solution. Each disposable bottle contains powder for oral administration as a solution following reconstitution.

Each HalfLyte and Bisacodyl Tablets Bowel Prep Kit contains:

**One pack bisacodyl delayed release tablets:** Four (5 mg each) bisacodyl delayed release tablets.

**One 2 liter bottle of HalfLyte<sup>®</sup> (PEG-3350, sodium chloride, sodium bicarbonate and potassium chloride for oral solution):** polyethylene glycol 3350 210 g, sodium bicarbonate 2.86 g, sodium chloride 5.60 g, potassium chloride 0.74 g, and 1.0 g flavoring ingredient (if applicable). When made up to 2 liters volume with water, the solution contains PEG-3350 31.3 mmol/L, sodium 65 mmol/L, chloride 53 mmol/L, bicarbonate 17 mmol/L and potassium 5 mmol/L.

All reconstituted solutions are clear and colorless.

## Rx only

## STORAGE

Store at 20-25°C (68-77°F). Excursions permitted between 15-30°C (59-86°F). When reconstituted, you may keep solution refrigerated. Use within 48 hours.

Lemon-Lime HalfLyte and  
Bisacodyl Tablets  
Bowel Prep Kit

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